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SCIENCE RESOURCES STUDIES

HIGHLIGHTS

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Substantial Shift Toward Slower R&D Growth Reported For Decade's End

Highlights

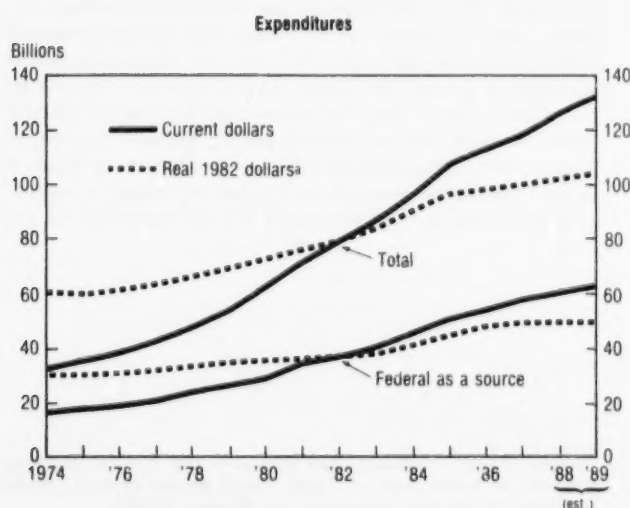
• The Nation is expected to spend \$132 billion on research and development (R&D) in 1989, or about 5 percent more than the amount estimated for 1988. After adjusting for expected inflation, this represents an increase of 1 percent, the lowest rate of real R&D growth since 1975.¹ The 1989 estimate also reflects a continuation in the pattern of relative-

ly small gains in annual R&D expenditures that began in 1986. The lackluster performance is attributable both to a downturn in R&D funding growth by industry and to tightening Federal budgetary constraints.

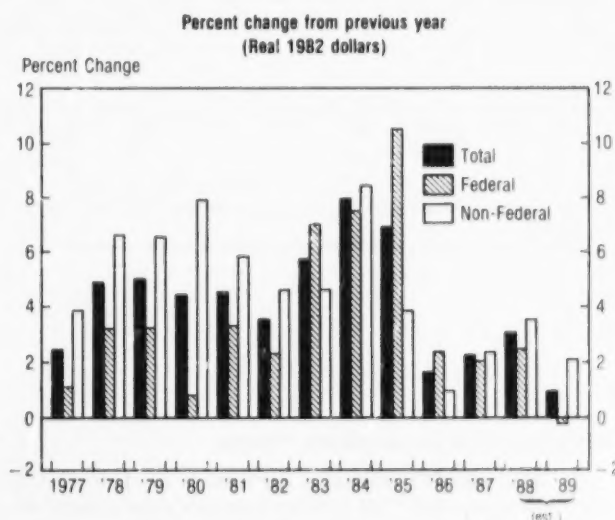
• Real R&D expenditures grew at a rather steady 4.5-percent average annual rate over the 1977-82 period. This rate increased to 6.9 percent from 1982 to 1985. Based on preliminary 1986 estimates, real R&D growth was thought then to have slipped somewhat (by 2 or 3 percentage points). However, a considerably greater slowing is indicated from recently available survey data: Real spending on R&D increased only about 2 percent both in 1986 and in 1987. Inflation-adjusted 1988 R&D expenditures are expected to be up by 3 percent (chart 1).

¹The estimated 1986-89 growth in real R&D expenditures is based on an assumed 4-percent change in the GNP implicit price deflator, as estimated by the Office of Management and Budget.

Chart 1. National R&D expenditures



^aBased on GNP implicit price deflator.
SOURCE: National Science Foundation, SRS



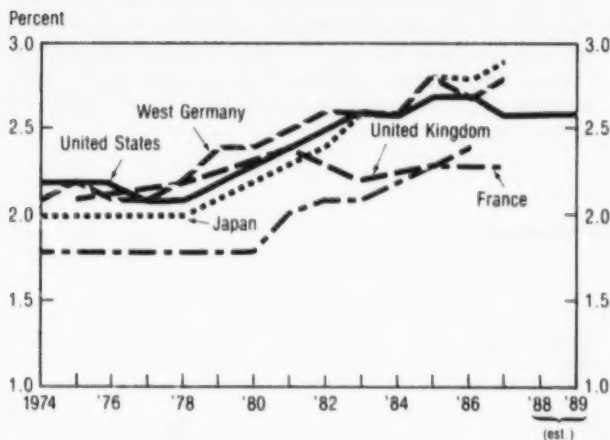
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- As a result of this recent slowing in R&D growth, coupled with continued expansion in the national economy, the proportion of U.S. gross national product (GNP) spent on R&D dropped slightly from 2.7 percent in 1985 to an estimated 2.6 percent in 1989. The U.S. R&D/GNP ratio is below that for both Japan and West Germany where, according to the latest available data (1987), 2.9 percent and 2.8 percent, respectively, of GNP was spent on R&D (chart 2). If defense-related R&D expenditures are excluded, the estimated 1989 U.S. R&D/GNP ratio of 1.7 percent is well below that of West Germany (2.6 percent in 1987) and Japan (2.8 percent in 1986).

- As a share of the R&D total, it is expected that development will account for 65 percent of U.S. expenditures in 1989, basic research for 14 percent, and applied research for 21 percent. These percentage shares have remained relatively stable over the decade: In the first half of the eighties, there was a slight shift toward development. Since 1985, the proportion of the R&D total devoted to basic research has increased, whereas the applied research share has declined.

- The geographic distribution of R&D performance continues to be highly concentrated in the United States. According to the latest data available, two-thirds of the R&D performed nationwide was undertaken in 10 States.

Chart 2. International R&D/GNP



NOTE: Data for the United Kingdom are available only for 1975, 1978, 1981, 1983, 1985, and 1986.

SOURCES: National Science Foundation, SRS and Organization for Economic Co-operation and Development.

National R&D Expenditure Trends

An estimated \$132 billion is expected to be spent on U.S. R&D efforts in 1989. This is more than twice the amount expended at the beginning of the decade (\$63 billion in 1980). Yet R&D growth has slowed considerably during the past few years. Measured in inflation-adjusted 1982 dollars, national

R&D expenditures increased at a 4.5-percent average annual rate from 1977 to 1982. Over the 1982-85 period, annual growth in such expenditures accelerated to 6.9 percent and was led, to a large extent, by major increases in Federal defense spending. Not since the early sixties had national R&D spending grown so rapidly during any 3-year period. This pattern of a generally increasing rate of real R&D growth changed abruptly in 1986.

Based on preliminary data collected by the National Science Foundation, the rate of increase in real R&D spending was expected to slow by 2 or 3 percentage points in 1986.² But it now appears that the magnitude of deceleration was even greater: Real R&D expenditures increased only about 2 percent both in 1986 and in 1987. A slight pickup in R&D spending is expected in 1988 (3 percent after adjusting for inflation), followed by 1-percent real R&D growth estimated for 1989. Overall, R&D is expected to average 2-percent annual real growth during the 1985-89 period. Slackening in both Federal and non-Federal support has contributed to this slowing in national R&D expenditure growth.

Much of the gain in the Nation's support for R&D during the eighties is attributable to large increases in Federal defense spending. The Federal Government has consistently provided approximately one-half the total R&D expenditures in the United States, and 66 percent of the 1989 Federal R&D total is estimated for defense activities of the Departments of Defense (DOD) and Energy (DOE).³ In 1980, such defense-related spending accounted for one-half of Federal R&D funding. While increases in defense expenditures are responsible for fully 90 percent of the estimated growth in Federal R&D support from 1980 to 1989, most of this growth took place in the first half of the decade.

Within the framework of overall restraint to reduce the budget deficit, the rate of increase in total (that is, both defense- and civilian-related) Federal real R&D support slowed considerably in 1986 to 2.4 percent, down from 10.5-percent growth one year earlier (chart 1). Federal R&D support was further curbed as a result of fiscal reductions mandated by the Gramm-Rudman-Hollings Act.⁴ In 1987—and for the first time in the eighties—the annual rate of growth in Federal support for defense-related R&D was lower than for civilian-related R&D. Within the context of spending limitations imposed by the 1987 Bipartisan Budget Agreement, growth in Federal nondefense R&D also is expected to be higher than for defense R&D funding in 1988 and 1989. Over the entire 1986-89 period, Federal support for defense R&D is expected to increase by 0.5 percent annually in real terms; the average annual rate of inflation-adjusted growth in Federal nondefense R&D is estimated at 6.2 percent.

²National Science Foundation, "Real Increase in 1986 National R&D Funds Estimated at Lowest Rate in Eleven Years," *Science Resources Studies Highlights* (NSF 88-303) (Washington, D.C., February 19, 1988).

³These percentage share estimates of defense-related R&D expenditures are based on the President's 1989 Federal budget totals.

⁴The Balanced Budget and Emergency Deficit Control Act of 1985.

Non-Federal support for R&D also slowed considerably in the second half of the eighties, particularly as reported for industry performers. For example, from 1975 to 1984, companies' funding of R&D increased at an average annual real-term rate of 6.1 percent. Such expenditure growth slowed to 4 percent in 1985, was flat in 1986, and is expected to average about 2 percent per year over the 1986-89 period. Although the slowdown cannot be pinned on any single factor, industry officials cite smaller increases in sales and profits as the major reason for the deceleration. In addition, the slowing in Federal cosupport for defense-related R&D is a likely contributor to the sluggishness in industrial R&D funding, and corporate mergers also may have contributed somewhat to slower company R&D growth rates.⁵

R&D Expenditure Estimates for 1989

Federal R&D support is estimated at \$63 billion in 1989 (table 1), which is about 3.5 percent more than the amount estimated for 1988. Based on an expected 4-percent rate of inflation, the change in Federal real-term support, therefore, may actually be negative in 1989; this would be the first time since 1975 that there has been a decrease in real Federal R&D spending. Non-Federal support of almost \$70 billion is expected in 1989. This represents an increase of 6 percent from the previous year, or about 2 percent after adjustment for inflation. Of the non-Federal total, industry support is estimated at \$64 billion; university and college support at \$3.8 billion; and nonprofit support at \$1.8 billion. These amount to real-term increases of 2 percent, 6 percent, and 2 percent, respectively, from estimated 1988 R&D support levels.

In terms of performance, industry accounts for an estimated 72-percent share of the Nation's total 1989 R&D expenditures. The \$95 billion expected to be spent on industrial R&D represents a 5-percent increase from 1988, or 1 percent in real terms. Funding for 66 percent of industry's expected performance total will be provided by companies' own funds; the rest is estimated to come from the Federal Government (table 2).

The Federal Government is expected to account for \$15 billion, or 11 percent, of the 1989 U.S. performance total. This is only a 2-percent increase from 1988 levels. After adjusting for inflation, it represents a 2-percent decline that is expected to be taken mostly by DOE, the Departments of Commerce, and Health and Human Services. In 1988, Federal intramural R&D performance is estimated to be up 5 percent in real terms, whereas such performance in 1987 actually fell 1 percent in nominal dollars (and was down 4 percent in real terms) largely as a result of substantial cutbacks in DOD spending activities.

Most of the remaining R&D is performed by the Nation's universities and colleges—including work done in federally funded research and development centers (FFRDCs) administered by universities and colleges. In 1989, universities

Table 1. Funds for research and development

Year	Total	Federal Government	Industry ¹	Academic sector		Other nonprofit institutions ¹
				Universities & colleges	Associated FFRDCs ²	
	By performer					
1977	42,783	6,012	29,825	4,067	1,384	1,495
1978	48,129	6,811	33,304	4,625	1,717	1,672
1979	54,933	7,417	38,226	5,361	1,935	1,994
1980	62,594	7,632	44,505	6,061	2,246	2,150
1981	71,866	8,425	51,810	6,845	2,486	2,300
1982	79,364	9,141	57,995	7,324	2,479	2,425
1983	87,280	10,582	63,403	7,883	2,737	2,675
1984	97,793	11,572	71,470	8,623	3,118	3,010
1985	107,757	12,945	78,269	9,694	3,529	3,320
1986	112,497	13,535	80,631	10,926	3,900	3,505
1987 (prelim.)	118,782	13,413	85,500	12,082	4,202	3,585
1988 (est.)	126,115	14,500	90,600	13,000	4,400	3,615
1989 (est.)	132,350	14,750	95,350	13,900	4,650	3,700
	By source					
1977	42,783	21,594	19,629	888	—	672
1978	48,129	23,876	22,450	1,037	—	766
1979	54,933	26,815	26,082	1,198	—	838
1980	62,594	29,453	30,914	1,326	—	901
1981	71,866	33,404	35,946	1,555	—	961
1982	79,364	36,512	40,101	1,735	—	1,016
1983	87,280	40,691	43,524	1,936	—	1,129
1984	97,793	45,377	49,107	2,107	—	1,202
1985	107,757	51,668	52,358	2,377	—	1,354
1986	112,497	54,331	53,950	2,789	—	1,427
1987 (prelim.)	118,782	57,291	56,722	3,145	—	1,624
1988 (est.)	126,115	60,500	60,430	3,470	—	1,715
1989 (est.)	132,350	62,700	64,035	3,800	—	1,815

¹Includes expenditures for federally funded research and development centers (FFRDCs) administered by this sector. They account for less than 5 percent and 25 percent, respectively, of the industry and nonprofit performance totals.

²FFRDCs administered by individual universities and colleges and by university consortia.

SOURCE: National Science Foundation, SRS.

Table 2. Estimated funding for research and development by source of funds: 1989

[Dollars in millions]

Source of funds	Total	Performers			
		Federal Government	Industry ¹	Universities and colleges ¹	Other nonprofit institutions ¹
Total	\$132,350	\$14,750	\$95,350	\$18,550	\$3,700
Federal Government	62,700	14,750	32,750	12,900	2,300
Industry	64,035	—	62,600	920	515
Universities and colleges	3,800	—	—	3,800	—
Other nonprofit institutions	1,815	—	—	930	885

¹Includes expenditures for federally funded research and development centers (FFRDCs) administered by this sector.

SOURCE: National Science Foundation, SRS.

⁵National Science Foundation, "Economic Outlook and Corporate Mergers Dampen Growth in Company R&D," *Science Resources Studies Highlights* (NSF 88-311, Washington, D. C., March 11, 1988).

and their associated FFRDCs are expected to perform \$19 billion of R&D, or 14 percent of the U.S. total. FFRDC R&D performance is expected to be up by 2 percent in real terms and that of other university and college performers by 3 percent. Of the various sectors of the economy, real R&D performance growth during the latter part of the eighties is expected to be strongest for the academic sector (excluding FFRDCs). From 1985 through 1989, such R&D performance is expected to increase at a 6.1-percent annual rate, compared to average annual real R&D growth of 1.8 percent for industry. Estimated Federal intramural R&D performance during this period is relatively flat (0.1 percent real growth annually) and the change in R&D performance by the nonprofit sector is expected to be slightly negative (down 0.4 percent annually in real terms).

Basic Research, Applied Research, and Development

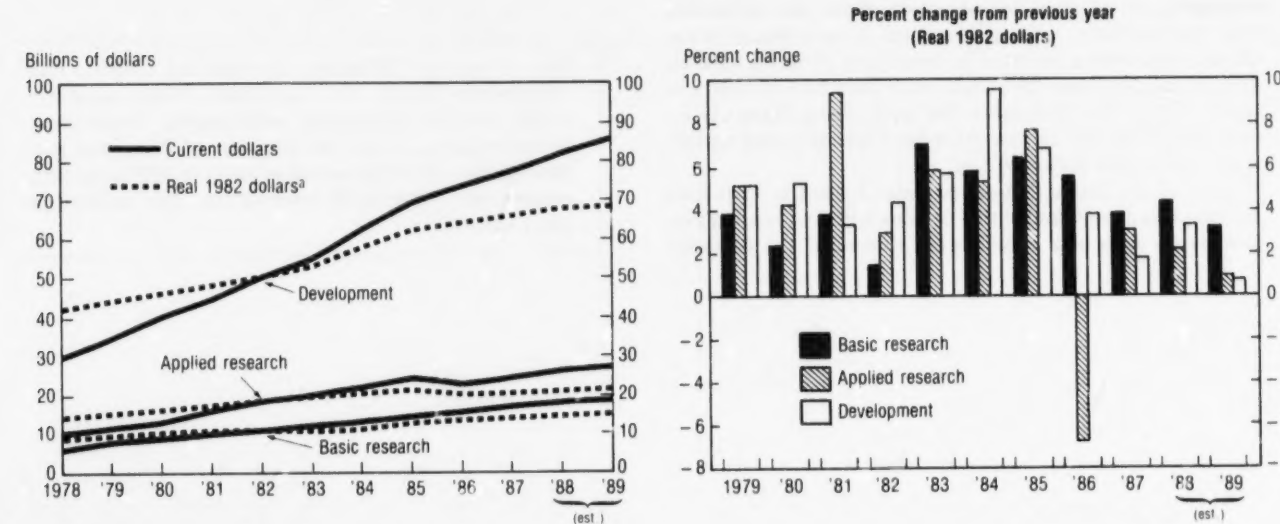
The Nation is expected to spend \$19 billion on basic research in 1989, \$27 billion on applied research, and \$86 billion on development. These totals represent real-term increases from 1988 levels of 3 percent for basic research, and less than 1 percent each for applied research and development. Since 1985, growth in basic research funding annually has exceeded funding growth of both applied research and

development (chart 3). As a result, the basic research share of total R&D expenditures increased from under 13 percent in 1985 to 14 percent estimated in 1989. The corresponding development share also increased almost one percentage point to an estimated 65 percent of total R&D. The applied research share is expected to fall 2 percentage points—to 21 percent of total: This is largely a result of a one-time reduction—in 1986—in industry's defense-related applied research effort.

Over the entire decade, however, spending on development was considerably higher than on research. Expected 1989 development expenditures are \$46 billion higher than the 1980 investment in development. By comparison, spending on basic research in 1989 is expected to be \$10 billion more than in 1980, and expected applied research funds are \$13 billion greater.

Much of the growth in development is a result of the major increases in Federal support for defense R&D, which is about 90 percent development. In the first half of the eighties, Federal R&D funds for development grew faster than for research in both absolute and relative terms. Even with the recent gains in Federal support for civilian R&D, which has a relatively higher research component, defense-related R&D continues to receive the majority of Federal R&D funds—by a 2-to-1 margin.

Chart 3. National basic research, applied research, and development expenditures



^aBased on GNP implicit price deflator.
SOURCE: National Science Foundation, SRS

As a share of the national basic research total, Federal support has declined considerably in the eighties—from 70 percent in 1980 to an estimated 65 percent in 1989. This decline, however, does not indicate a diminution in Federal support for basic research: Such support is up about 37 percent in real terms over the decade. Rather, it is a reflection of a growing tendency for other sectors to fund basic research. For example, universities and colleges (excluding FFRDCs administered by this sector) are expected to account for 50 percent of the Nation's 1989 basic research performance. Their share of the total is up slightly since 1980 (48 percent). In 1980, however, non-Federal sources provided only 29 percent of the basic research funds used by academia. In 1989, they are expected to provide 36 percent of such funds. Between 1980 and 1987 (the latest year for which these detailed data are available), there was a 226-percent increase in industrial support for university-performed R&D; nonprofit support to this sector was up 108 percent and R&D funds from State and local governments rose 107 percent. The use of institutional funds for academic R&D rose 155 percent during this 7-year period.

State Distribution of R&D Performance

Data are available on the geographic distribution of R&D expenditures by State for 1985. These include R&D performance by industry, academia, and Federal agencies, and the federally funded R&D activities of institutions that are part of the nonprofit sector.

The State distribution of R&D performance is highly concentrated. Five States (California, New York, New Jersey, Michigan, and Massachusetts) accounted for half of the U.S. total, and 10 States (adding Maryland, Texas, Pennsylvania, Illinois, and Ohio) accounted for two-thirds of the national effort. In each of these 10 States, more than \$3.5 billion was spent on R&D. The 30 smallest R&D-performing States collectively accounted for 10 percent of the R&D conducted nationwide—about \$10 billion in total.

Many of the States that are national leaders in total R&D performance have attained this ranking by being leading performers in each of the individual sectors of the economy

(table 3). For example, of the 10 States that led in total 1985 R&D performance, only Maryland was not ranked among the top 10 industrial performers and only Ohio was not ranked among the top 10 academic performers.

Table 3. States leading in R&D performance by sector: 1985

Total R&D (\$ millions)	Rank	All sectors	Industry	Federal Government	Academia
\$22,293	1	California	California	Maryland	California
8,371	2	New York	New York	D.C.	New York
6,722	3	New Jersey	Michigan	California	Massachusetts
6,370	4	Michigan	New Jersey	New Mexico	New Mexico
6,022	5	Massachusetts	Massachusetts	New Jersey	Illinois
4,951	6	Maryland	Pennsylvania	Virginia	Texas
4,372	7	Texas	Texas	Ohio	Maryland
4,348	8	Pennsylvania	Illinois	Alabama	Pennsylvania
4,154	9	Illinois	Ohio	Florida	Michigan
3,688	10	Ohio	Washington	Texas	New Jersey

SOURCE: National Science Foundation, SRS

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The national R&D expenditure data reported here are assembled from a variety of NSF surveys. A more detailed analytical report covering these data will be published in spring 1989: *National Patterns of R&D Resources: 1989*.

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